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Study of Waste Material for Concrete Brick Construction

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Abstract: The management of garbage is a critical issue in the modern world, particularly with regard to plastic and glass waste. Thousands of tonnes of plastic and glass are thrown in the trash every day, yet there aren't enough treatment and recycling options. Every day, a significant amount of plastic is thrown away or burned, contaminating the ecosystem and the atmosphere. Plastic trash build up in the environment poses a threat to both plant and animal life. Plastic is a material that is not biodegradable and takes thousands of years to disintegrate, polluting both land and water. Recycling plastic and glass garbage after their useful lives are through while generating economic value and causing the least amount of environmental harm is the secret to their sustainable management in a circular economy. Bricks are a common building material used to make masonry structures like walls and pavement. Numerous researches has been conducted on concrete that has been saturated with waste plastic and glass fibre, with positive outcomes and many benefits. Numerous testing have been carried out to manufacture eco bricks, including compression tests and water absorption tests.
Keyword: Concrete Bricks, Waste glass, Waste plastic, Water, Recycling.

I. INTRODUCTION

Plastic is a versatile, sturdy, and fairly priced material. These characteristics have led to the development of numerous products that are advantageous to society in terms of economic activity, employment, and level of living.The industrial-scale production of plastic began in 1950's. As of 2015, the world produced nine (9) billion tons of plastic since 1950s. In 65 years, merely nine percent (9%) of plastic waste was recycled and reused, twelve percent (12%) was incinerated, and the remaining seventy-nine percent (79%) has built up in landfills or ended up elsewhere in the environment (Ferris, 2017). Statistically, the remaining seventyninepercent (79%) of plastic wastes can be recycled in more than 500 years. Non-biodegradable and useful resource glass takes up valuable landfill space. In order to lessen the amount of glass wastedumped in landfills, alternative recycling techniques must be investigated. The use of plastic and glass in such materials not only promotes their utilisation but also decreases the cost of making concrete and has other indirect advantages, including cheaper landfill costs, energy savings, and environmental protection from potential pollution consequences. One of the oldest and most common building materials is brick. Depending on their size, colour, texture, origin, materials utilized, and forming process, the many varieties of bricks available on the market are employed. Bricks are an important component of industrial production processes in addition to being utilized in the construction of buildings.

II. OBJECTIVE

To study brick manufacturing by adding of plastic and Glass Waste.

III. LITERATURE REVIEW

Akhil Mathai Varkeyet al.The study utilizes Common Portland Cement (OPC) of 53 grade, along with fine and coarse aggregates, water, and both polypropylene plastic and glass wastes. Adhering to Indian standards, the analysis evaluates the properties of cement, fine aggregate, and coarse aggregate. An M20 mix with a proportion of 1:1.5:3 is employed for the research. Concrete bricks are cast with varying percentages of recycled polypropylene plastic (5%, 10%, 15%, and 20%) and a constant 5% recycled glass, and are subsequently subjected to curing. The compressive strength and water absorption of these bricks are tested at 7, 14, and 28 days.[1] This study explores the development of concrete bricks incorporating recycled glass and plastic waste. By sourcing these materials from local scrap markets, the research aims to effectively utilize waste products. The study investigates the properties of the resulting bricks through various tests, including compressive strength and water absorption. The findings indicate that replacing up to 15% of the coarse aggregate with recycled plastic and glass yields optimal results, as higher replacement rates tend to decrease the compressive strength of the bricks.

Siti Aishah Wahid et al.The primary goal of this research is to devise an effective method for utilizing plastic bottle waste, which poses a significant threat to ecological balance. Defective bottles were collected, crushed into small pieces, and then sieved to select the finest size for further use.

The mixture was prepared by combining sand, sand dust, and cement in a ratio of 9:9:4 in the mixer. Two buckets of water were added, mixed thoroughly, and then plastic materials were incorporated in specified ratios. The final mixture was poured into moulds to form bricks.

Compressive strength declines as the ratio of waste plastic increases. The brick with no plastic waste (0%) exhibited the highest compressive strength at 252.67 kN. This was followed by bricks with 5%, 10%, and 15% plastic waste, showing strengths of 236.67 kN, 121.33 kN, and 60.67 kN, respectively. The reduction in strength is likely due to the weakened adhesive bond between the plastic waste and the cement paste. Despite this, all mixtures maintained a water absorption rate below 15%, indicating that incorporating plastic waste into sand bricks is feasible.

John Rogel S. UrsuaEach brick mixture has a weight of 2.5 kg, with the sand content varying between 55% and 65%. The plastic waste makes up 29% to 39% of the mixture. Additionally, glass bottles account for 5%, and paper constitutes 1% of the total mixture. The effectiveness and quality of the bricks were assessed based on these varying compositions.[2]

The results indicated that as the sand content increases, so does the density of the bricks. According to ASTM C129 – Standard Specification for Non-Load-Bearing Masonry Units, which has lower compressive strength requirements than ASTM C90, the minimum requirement is 500 psi (3.45 MPa) for an individual unit and 600 psi (4.14 MPa) on average for three units. All sand brick specimens exceeded the 500 psi requirement for non-load-bearing masonry units for individual bricks. Additionally, the results showed that an increase in plastic content leads to a rise in compressive strength. However, Brick A, which contained 39% plastic by weight, achieved a compressive strength of 628.82 psi (4.34 MPa). This suggests that as the plastic reaches its molten state, the sand and crushed glass settle quickly, while the molten plastic and shredded paper float to the surface of the mixture. This indicates that an excessive amount of binder may decrease the compressive strength of sand bricks.

The results indicated that as the percentage of plastic waste in the bricks increased, the percentage of water absorption decreased. Brick A, containing 39% plastic waste, had a water absorption rate of 1.285%, while Brick B, with 34% plastic waste, had a rate of 1.443%. In contrast, Brick C, with 29% plastic waste, had a water absorption rate of 1.509%. The acceptance criteria for water absorption in bricks specify that they should not absorb more than 20% water. Therefore, the inclusion of plastic waste contributes positively to the performance of sand bricks.

In this test, a 4-inch common nail was used to scratch the brick surfaces, leaving only a very faint impression. The hardness of the bricks was attributed to the plastic waste, which served as a binder, along with sand and crushed glass bottles as fillers. As a result, all the sand brick specimens were classified as "Hard" based on the minimal impression made.

Joshuva A et al.In the present study, M15 grade concrete was designed with a mix proportion by weight of 1:2:4, and a water-cement ratio of 0.4. The objective was to investigate the properties of bricks.

During the experimental work, the physical properties of the materials used were thoroughly analysed. The M15 grade concrete was mixed and cured using potable water as part of the reference process.

The study involved varying the percentage of plastic in the mix while keeping the cement and fly ash quantities constant at 0.992 kg and 4.04 kg, respectively. For a 5% plastic content, the mix included 3.078 kg of M-sand and 0.162 kg of plastic glass. With a 10% plastic content, the M-sand quantity decreased to 2.916 kg, and the plastic glass increased to 0.324 kg. Finally, for a 15% plastic content, the M-sand was further reduced to 2.754 kg, while the plastic glass content rose to 0.486 kg.[3]

The materials were tested for average load and compressive strength after 7, 14, and 28 days of curing. For Specimen 1, the average load was 488 KN at 7 days, 612 KN at 14 days, and 816 KN at 28 days, with corresponding compressive strengths of 21.63 N/mm², 27.45 N/mm², and 33.65 N/mm². Specimen 2 showed an average load of 421 KN at 7 days, 635 KN at 14 days, and 872 KN at 28 days, with compressive strengths of 22.65 N/mm², 30.25 N/mm², and 36.54 N/mm². For Specimen 3, the average load was 462 KN at 7 days, 675 KN at 14 days, and 817 KN at 28 days, with compressive strengths of 22.96 N/mm², 31.26 N/mm², and 34.87 N/mm².

The flexural strength of the samples was measured at three different intervals. At 7 days, the flexural strengths were 5.5 N/mm², 5.32 N/mm², and 4.85 N/mm². After 14 days, these values increased to 7.12 N/mm², 6.98 N/mm², and 6.47 N/mm². Finally, at 28 days, the flexural strengths reached 8.32 N/mm², 7.96 N/mm², and 8.12 N/mm².

The study measured the dry weight, wet weight, and water absorbed by the samples. For the first sample, the dry weight was 7.14 kg, the wet weight was 7.42 kg, and the water absorbed was 280 grams. The second sample had a dry weight of 7.09 kg, a wet weight of 7.35 kg, and absorbed 260 grams of water. The third sample recorded a dry weight of 7.01 kg, a wet weight of 7.25 kg, and absorbed 240 grams of water.

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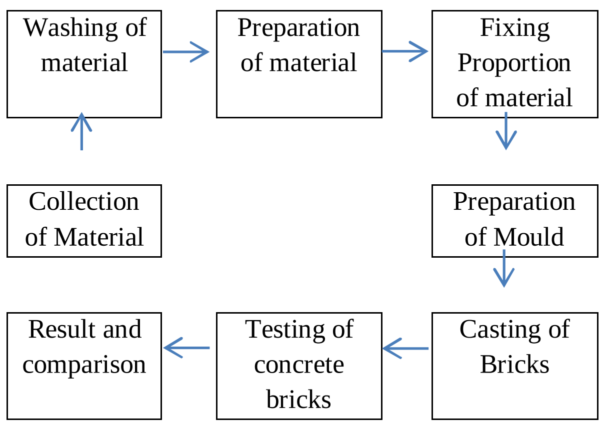
G.Venkatachalam et al.The compressive testing machine (CTM) is employed to evaluate the plastic soil bricks and identify those with the highest compressive strength. The mix percentages varied up to 30% of the total mixture. Details of the proportions are provided in bricks 1, 2, and 3.
The mix proportions for the bricks are detailed as follows:
For Brick 1, the composition includes 35% m-sand (750 grams), 30% cement (875 grams), 15% waste PVC (375 grams), 5% hydro tons powder (125 grams), and 15% waste glass (375 grams).
For Brick 2, the mix comprises 35% m-sand (750 grams), 30% cement (875 grams), 20% waste PVC (500 grams), 5% hydro tons powder (125 grams), and 10% waste glass (250 grams).
For Brick 3, the proportions are 35% m-sand (750 grams), 30% cement (875 grams), 10% waste PVC (250 grams), 5% hydro tons powder (125 grams), and 20% waste glass (500 grams).
The water absorptiontest results are as follows: Brick 1 absorbed 14.15%, Brick 2 absorbed 10.17%, and Brick 3 absorbed 15.12%.
In this test, bricks are dropped from a height of one meter. Bricks that shatter upon impact are considered to have a poor impact resistance and are deemed unsuitable for construction. However, the brick remained intact after being dropped from the specified height, indicating that it is of high quality.[4]
In this experiment, the surfaces of the bricks were scratched, and only a faint impression was left on the sand bricks after scratching with a fingernail. These results suggest that the fibrous concrete bricks possess adequate strength.
In this test, the structures made from broken bricks were examined for any defects, such as holes or lumps. The sand blocks were also checked to ensure they could be divided into equal portions. The inspection revealed that the sand brick construction was flawless, compact, and uniform.



Process of manufacture brick with the help of plastic and glass waste.

IV. MATERIAL

A. Cement

OPC grade 53 cement was used for the experimental work. According to IS standards, the cement was put through the following tests.

TABLE 1: Test on the cement

Sr. no.	Tests	Result
1	Fineness	9%
2	Standard consistency	32%
3	Initial setting time	Less than 30 min.
4	Final setting time	10 hrs
5	Specific gravity	3.06

B. Fine Aggregate
In accordance with the IS standard, the aggregate was selected. Sizes of fine aggregate range up to 4.75mm.

TABLE 2: Test on fine aggregate

Sr. no	Tests	Results
1	Specific gravity	2.65
2	Particle size distribution	Zone III, Fineness modulus 2.76, Uniformity coefficient 2.5
3	Bulking of sand	Max bulking 35.2%, water content at max bulking 7%
4	Water absorption	1.25%

C. Water
Drinkable water is used for blending and conditioning of concrete.

D. Plastic Waste
In today's world, plastic is extensively utilized for its convenient properties of being compact and lightweight. Common plastic items include bags, bottles, and food packaging. However, a significant issue with plastic is its inability to decompose. Composed of polymer chemicals, plastic is non-biodegradable, meaning it won't break down when buried in the earth. Despite its usefulness due to its flexibility, durability, and sturdiness, plastic items often end up as waste, polluting our air and land. Recycling involves converting waste materials into new products, thereby conserving potentially valuable resources.

The most extensively produced plastic is polyethylene terephthalate or PET. PET is a plastic used to form bottles which used as containers for liquids like water, soda, and juices with recycling number: 1 (Manjarekar, Gulpatil, Patil, Nikam, &Jeur, 2017). PET materials possess various characteristics such as easy to bond, easy to reshape, recyclable, and lightweight. On the other hand, the main component of plastic bags or grocery bags is HDPE or High-Density Polyethylene with recycled number: 2 and LDPE or Low-Density Polyethylene with recycling number: 4. HDPE plastic materials used are moisture-resistant, impact-resistant, opaque and lowerrisk of leaching as well as considered to be safe. LDPE are impact-resistant, moisture resistant, and chemical resistant. It is also considered to be safe among the recycling symbols.[5]

Fig.1 Plastic waste

E. Glass Waste
Glass is an amorphous (non-crystalline) that in essence, a super cooled liquid and not a solid. Glass can be made with excellent homogeneity in a variety of forms and sizes from small fibres to meter-sizes pieces. Primarily glass is made up of sand, soda ash, limestone and other additives (Iron, Chromium, Alumina, Lead and Cobalt). Glass has been used as aggregates in construction of road, building and masonry materials.

India generates 3 million tonnes of glass waste annually, with around 45% being effectively recycled, while the rest is disposed of in landfills.

Utilizing glass waste in concrete bricks can be a highly effective recycling strategy. By incorporating crushed glass into the brick mix, manufacturers can create durable, aesthetically appealing bricks with unique color and texture. This approach not only diverts glass waste from landfills but also reduces the need for raw materials in brick production. The inclusion of glass can enhance the bricks' strength and insulation properties, contributing to more sustainable and eco-friendly construction solutions.

Fig.2: Glass waste

V. CONCLUSION

Research indicates that replacing 15% of coarse aggregate with plastic and glass waste is optimal. Beyond this 15% threshold, the compressive strength of the brick declines. Future research should focus on grinding waste materials into fine powder and incorporating them in specific proportions to achieve maximum packing density. This approach could potentially enhance the compressive strength of the mixture. Additionally, introducing a binder or plasticizer into the mix may improve the bond between the plastic surfaces and cement particles, further increasing the material's overall strength. The study found that all sand brick specimens exceeded the ASTM C129 minimum strength requirement of 500 psi (3.45 MPa) and showed excellent performance with less than 20% water absorption. As the percentage of plastic waste in the bricks increased, water absorption decreased. The bricks were classified as "Slight" (≤ 10%) in efflorescence, and the hardness test showed only a light impression from a common nail. These results suggest that sand bricks made from non-hazardous waste could be a promising alternative for non-load-bearing walls and help reduce solid waste. The properties of the plastic and glass bricks were evaluated through various tests, including compressive strength and water absorption tests. Plastic was replaced in the bricks at levels of 50%, 75%, and 100% to test and validate this new brick form. Made from waste plastic and glass, these bricks have the potential for widespread use in all types of building construction activities. The study tested three brick compositions with varying percentages of waste PVC and waste glass, achieving water absorption rates ranging from 10.17% to 15.12%. The impact resistance test demonstrated the high durability of the bricks, as they remained intact when dropped from a height of one meter. Additionally, the bricks showed minimal surface damage and had a uniform, compact structure upon inspection. These findings indicate that the plastic soil bricks possess sufficient strength and quality, making them suitable for construction applications. In this study, concrete brick development employing glass and plastic trash that has been recycled is discussed. This study also tries to appropriately utilize waste materials since plastic and glass are waste products that are bought from the local scrap market. The comprehensive strength decreases with increasing waste plastic ratios.

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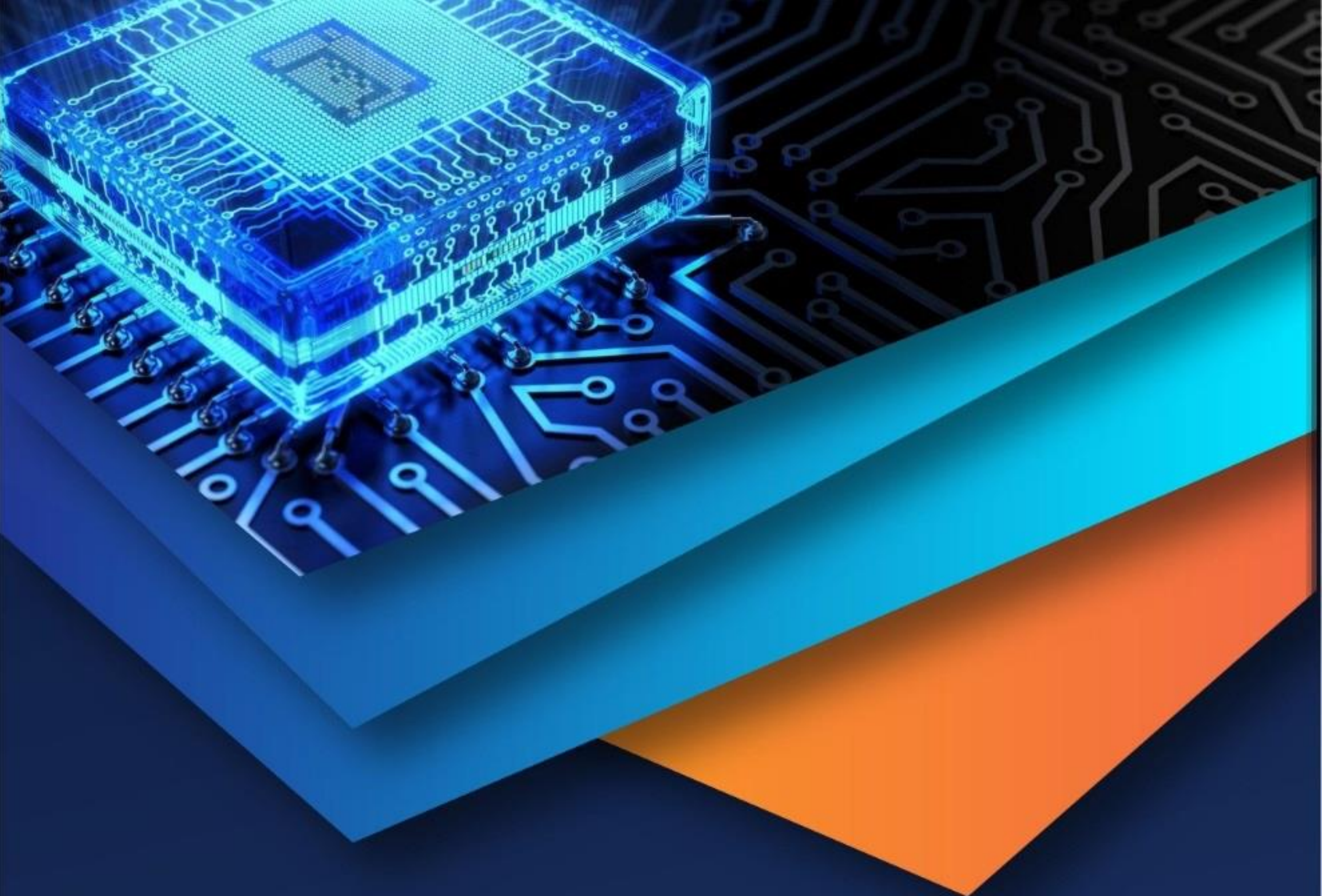

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